Naval Submarine Medical Research Laboratory

NSMRL Report 1141 23 June 1989

EVALUATION OF A COMPUTER-ASSISTED DENTAL DIAGNOSTIC SYSTEM BY NAVY HOSPITAL CORPSMEN

by

Karen Fisherkeller
and
Robert Beaudry, CAPT, DC, USN

Released by:

C. A. Harvey, CAPT, MC, USN
Commanding Officer
Naval Submarine Medical Research Laboratory

EVALUATION OF A COMPUTER-ASSISTED DENTAL DIAGNOSTIC SYSTEM BY NAVY HOSPITAL CORPSMEN

by

Karen FISHERKELLER and Robert BEAUDRY, CAPT, DC, USN

NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

NSMRL REPORT NO. 1141

Naval Medical Research and Development Commmand
Research Work Unit MM33C30.002-5044

Approved and Released by

C. A. HARVEY, CAPT, MC, USN
Commanding Officer
NavSubMedRschLab

SUMMARY PAGE

PROBLEM:

To evaluate the computer-assisted diagnostic program for dental pain with data collected by Navy hospital corspmen, to collect data on difficulties encountered by the corpsmen in their use of the system, and to obtain the corpsmen's feedback regarding the usefulness of the system for managing patients with dental pain.

FINDINGS:

The computer-assisted dental program produced diagnoses which were exact or logically consistent with the diagnosis made by the dentist 83% of the time. The corpsmen would use the dental program in their management of dental emergencies which occur at sea. They found the treatment recommendations made by the program especially helpful. In future revisions, the corpsmen requested more flexibility in data entry, questions that were more clearly worded, and greater detail to definitions of terms, procedures and dental conditions.

APPLICATION:

Findings can assist in the development of a computer-assisted dental diagnostic system that best meets the needs of independent duty corpsmen in their management of dental patients at sea.

ADMINISTRATIVE INFORMATION

This investigation was conducted under Naval Medical Research and Development Command Research Work Unit MM33C30.002-5004. It was submitted for review on May 19, 1989 and approved for publication on June 23, 1989. It has been designated as Naval Submarine Medical Research Laboratory Report No. 1141.

ABSTRACT

A computer-assisted dental program to assist independent duty corpsmen in the diagnosis and management of patients who present at sea with dental pain produced diagnoses which were exact or logically consistent with the diagnosis made by the dentist 83% of the time. The corpsmen found the computer-assisted dental program valuable to the diagnosis and managment of patients with dental pain. They would use the the dental program in their management of dental emergencies which occur at sea. They found the treatment recommendations made by the program especially helpful. In future revisions, the corpsmen requested more flexibility in data entry, questions that were more clearly worded, and greater detail to definitions of terms, procedures, and dental conditions.

Introduction

A computer-assisted diagnostic and treatment program for dental pain was first developed at the Naval Dental Research Institute, Great Lakes, IL [1,2] and later adapted to MS-DOS format and implemented on an IBM-PC/AT by the Naval Submarine Medical Research Laboratory (NSMRL), Groton, CT.[3] The program is rule-based, designed for use with trauma and non-trauma related dental pain and also provides a differential diagnosis for soft tissue lesions. The program considers 35 dental conditions in its evaluation of patients with trauma and non-trauma related dental pain. A separate module provides textbook style assistance to the user seeking information about soft tissue lesions. The program is intended for use by independent duty corpsmen in their management of patients who present with dental pain at sea.

Symptom findings can be recorded on dental questionnaires, or the user can enter information directly into the computer program. Use of the questionnaires is optional, unless the dental patient and computer program are in separate locations. The questionnaires permit data to be gathered when it is inconvenient or undesirable to use the computer at the time of the patient evaluation.

Whether data are recorded on a questionnaire or entered directly into the program, the user must first classify the patient's presenting problem into one of ten categories. There is a category for trauma related dental pain and one for the differential diagnosis of soft tissue lesions. There are eight categories of non-trauma related dental pain. These are: Tooth Specific, Teeth, Generalized/Multiple; Gingiva, Specific Area; Gingiva, Generalized; Oral Mucosa, Tooth Associated; Temporomandibular Joint/Muscle; Dental Extraction Site; and Tissue Swelling. A different questionnaire is used for each of the categories considered by the program.

Each questionnaire consists of a set of questions and branch points. The questions are ones used by the program to collect patient data. The branch points in the questionnaire reflect the implicit logic of the diagnostic program and direct the user to gather further information depending on the patient's responses to previous questions. If the corpsman follows the directions of the branch points he will respond only to those questions required by the computer program to reach a diagnosis.

The user enters the patient's symptom findings into the program. To make a diagnosis, the program compares dental findings against a set of diagnostic rules and makes a diagnosis when, and if, the conditions of a rule are met. Sometimes the program cannot reach a diagnosis based on the information provided, and, in these cases, a statement to that effect is displayed.

Diagnostic rules for the dental program were compiled from dentists and the dental literature.[1] The system was initially reviewed by seven dentists who generated over 200 simulated dental emergencies. Simulated cases were evaluated by the computer-assisted

diagnostic program, and, based upon the results, minor changes were made to the rules. Subsequently, the dental program was tested in a large Navy dental clinic. Data were collected by a dental technician, and a diagnostic accuracy of 88% was obtained for 80 real patients on a subset of dental conditions considered by the program.

The dental diagnostic program was further evaluated in two studies conducted at NSMRL.[3] In these studies, dentists supplied "classic" findings for each of the 35 dental conditions considered by the program. When the "classic" findings for each condition were entered into the diagnostic program, the program produced diagnoses which agreed with the "classic" diagnosis 78% of the time. Accuracy was also evaluated according to the therapeutic interventions available to the corpsman at sea. These are: (a) evacuate immediately; (b) treat aboard - potential for condition to warrant evacuation; and (c) treat aboard - return to duty. The program correctly distinguished between dental conditions requiring immediate evacuation and those which can reasonably be managed aboard the submarine by the corpsman.

Up to now the program has not been used by Navy corpsmen. The purpose of the present study is to collect data on difficulties encountered by corpsmen in using either the dental questionnaire or diagnostic program, to obtain the corpsmen's feedback regarding the usefulness of the system for managing patients with dental pain, and to gather the corpsmen's suggestions for improving either the dental questionnaires or diagnostic program. This information will be used to create a program that best meets the needs of corpsmen in their management of dental patients at sea.

Subjects

Five Navy corpsmen participated in the study. One was a submarine qualified, independent duty technician; two were field medical technicians, one was a cardio-pulmonary technician and one was an optical technician. Two were chief petty officers, one was a 1st class petty officer, and one was a 2nd class petty officer. Since the system had never been tested by any group of corpsmen, we felt that the opportunity for corpsmen to comment and report on difficulties encountered in using the system outweighed any disadvantage due to specific differences in training.

Procedure

Over a two day period, the corpsmen were trained both in the use of the dental questionnaires for collecting patient information and in the use of the diagnostic program for obtaining a diagnosis. Training focused on the questions used to collect patient information, dental terminology, and diseases considered by the program. In addition to classroom instruction, the corpsmen received approximately four hours of hands-on training in the examination procedures required by the dental questionnaires by the dental officer responsible for the dental curriculum at the Naval Undersea Medical Institute, Groton, CT. He stated that the training provided the corpsmen with dental skills and knowledge equivalent to the corpsmen trained for independent duty aboard submarines.

After completion of training, each corpsman was assigned one morning a week for a month to the Branch Dental Clinic, NAVSUBASE NLON, Groton, CT. When a patient in acute dental pain presented at the clinic, he was triaged by a dentist to determine if he required immediate attention or if he could tolerate first being evaluated by the corpman. This decision was determined primarily by the patient's level of pain; if the patient was holding his head, crying, or in obvious severe pain he was given immediate attention. The triage interview was as brief as possible to minimize bias in the patient's responses and the corpsman was not present during the triage. The dentist asked the patient a few, non-specific questions regarding the location, possible cause and duration of pain. The dentist did not respond to patient questions or offer a tenative diagnosis. Dental patients were male and female, active duty and retired personnel, 17 years or older in acute dental pain.

Corpsmen used a dental questionnaire as a guide for interviewing the patient. Dental questionnaires consist of a list of questions and branch points. The branch points direct the corpsman to gather further information depending on the patient's responses to previous questions. Branch points eliminate the need for the corpsman to complete all items on a given questionnaire. By following the directions provided by the branch points, the corpsman will collect only that information required by the computer program for a diagnosis. The corpsman assessed the nature of the dental problem on the basis of the patient's complaint clarified by a standard history and a cursory exam. The corpsman then selected the appropriate questionnaire to begin a structured history and physical exam as directed by the questions and branch points. The questionnaire sometimes required the corpsman to obtain information from the patient's dental record and/or examine the patient's mouth with the aid of an intra-oral mirror. In addition, the corpsman was sometimes required to perform routine, non-invasive examinations, i.e., percussion and palpation of the affected area. Normally, the examination was completed in ten to fifteen minutes.

After completing the dental questionnaire, the corpsman made his own diagnosis without the aid of the computer. He was encouraged to select from among the 35 diagnoses considered by the program but, if he felt another was more appropriate, he specified the diagnosis. The corpsman directed the patient to the dentist and then entered the patient's responses to the questionnaire into the computer-assisted dental program. The corpsman was asked to note any difficulties he encountered in either administering the questionnaire or using the computer program.

The dentist examined and treated the patient. Based on his examination, the dentist selected a diagnosis(es) from the list of 35 diagnoses considered by the dental program. If he felt the diagnosis was other than one considered by the program, he specified the diagnosis. The dentist also classified the patient's dental problem into one of ten broad categories used by the program and which correspond to the ten questionnaires available to the corpsman.

At the end of the study each corpsman completed a six page form evaluating the dental questionnaire and diagnostic program. The corpsmen rated characteristics of the questionnaire and diagnostic program on a six point scale from strongly agree to strongly disagree. Items concerned clarity of questions, familiarity with dental terminology and examination procedures required by the system, perceived usefulness of the system for managing dental patients, and trust in the diagnostic and treatment suggestions made by the program. A copy of this form is included as Appendix A.

Results

Dental Conditions Examined

In this study the corpsmen examined 32 patients with acute dental pain. There was no instance when a patient was excluded from the study because the delay in using the questionnaire would have unacceptably delayed treatment. All the corpsmen's examinations were conducted prior to an examination by the dentist. The range of dental problems which were brought to the clinic were the common causes of acute dental pain. Table 1 lists the dental conditions considered by the program and the number of times each condition was seen during the study.

Table 1. Thirty-five dental conditions considered by the trauma and non-trauma related dental program and the number of times each dental condition was diagnosed by a dentist.*

1 Abscess/infection/cellulitis	__Fractured mandible
__Acute apical abscess	__Fractured maxilla
1 Acute apical periodontitis	__Fractured facial bones
__Acute herpetic gingivostomatitis	6 Irreversible pulpitis
1 Acute gingivitis	__Internal derangement of the TMJ
2 Carious lesion (decay)	__Localized alveolar osteitis
1 Dentin hypersensitivity	__Maxillary sinusitis
1 Defective restoration	__Myofascial pain/muscle spasms
__Displace/mobility of tooth, favorable prognosis	3 Necrotizing ulcerative gingivitis
__Displace/mobility of tooth, guarded prognosis	__Neurologic injury
2 Endo/perio combined problem	__Osseous sequestrum
2 Enamel fracture	2 Occlusal trauma
__Food impaction	1 Periodontal abscess
__Fractured crown, small pulp exposure	3 Periocoronitis/erupting tooth
__Fractured crown, large pulp exposure	2 Reversible pulpitis
1 Fractured crown, pulp not exposed	__Root fracture
__Fractured alveolar bone	__Total avulsion, good candidate for replant
	__Total avulsion, poor candidate for replant

*There are only 29 diagnoses because on 3 of the 32 cases the dentist made a diagnosis of apthous ulcer, a condition included in the module for the differential diagnosis of soft tissue lesions. This module provides textbook style assistance about soft tissue lesions.

Corpsman - Dentist Agreement

The presenting dental problem of each patient was classified by the examining dentist into one of ten categories corresponding to the ten sections of the diagnostic program. Table 2 lists these categories. Next to each category are: a) the number of patients classified by the dentist into that category, b) the number of patients classified by the corpsmen into that category, and c) the number of times the corpsmen's selection corresponded to the category selected by the dentist. For example, of the 32 patients examined, the dentist identified 18 patients with a problem related to a specific tooth. On 17 of these patients, the corpsmen appropriately selected the "Tooth Specific" dental questionnaire to use in interviewing the patient. For the remaining patient, the corpsmen selected a different questionnaire. The corpsmen used the tooth specific questionnaire for 26 of the 32 patients in this study.

Table 2. Dental categories, the number of patients classified by the dentist and corpsmen (HM) into each category, and the number of times the corpsmen's questionnaire selection corresponded to the one made by the dentist.

Dental Category	Dentist	HM	HM-Dentist Correspondence
Soft Tissue Lesion	3	1	1
Trauma Related Injury	1	1	0
*Tooth, Specific	18	26	17
*Teeth, Generalized	1	1	0
*Gingiva, Specific Area	6	1	1
*Gingiva, Generalized Area	2	2	2
*Oral Mucosa, Tooth Associated	1	0	0
*Temporomandibular Joint/Muscle	0	0	0
*Dental Extraction Site	0	0	0
*Tissue Swelling	0	0	0

* Non-trauma related category.

Branching Errors

Errors in following the directions provided by the branch points were identified by examining the completed questionnaires. For 12 of the 32 dental patients, the corspman made no errors in interpreting the directions given by the branch points. On the remaining 20 cases, the corpsmen made 1 error (on 12 cases), 2 errors (on 3 cases), or 3 errors (on 5 cases). In most cases, the errors resulted in the collection of more information than was required by the computer to make a diagnosis. However, on three cases, the errors resulted in the failure to collect the required information and, as a result, the computer was unable to make a diagnosis for these cases.

Computer Diagnoses

Patient data collected by the corpsmen were entered into the computer and the diagnoses generated by the computer were recorded. The computer makes a diagnosis when, and if, the symptom findings match the requirements of a diagnostic rule. It is not only possible but common for the program to arrive at multiple diagnoses. In general, the other diagnoses which accompany the "correct" diagnosis are often related, if not causal, to the patient's dental condition. In this study, the computer program arrived at a single diagnosis on eight cases, arrived at two diagnoses on six cases, and made three or more diagnoses on the remaining cases.

The diagnoses made by the dentist were accepted as the final diagnoses against which the computer-generated diagnoses and the diagnoses made by the corpsman were compared. The degree of agreement between the computer, the corpsman and the dentist was defined according to the classification schema used in an earlier evaluation of the system [1]. This schema classifies agreement into three categories: 1) exact match or logically consistent diagnosis; 2) non-match; and 3) other. A logically consistent diagnosis, though not exact match, is defined as a diagnosis consistent with the information entered into the program and for which the recommended treatment is consistent with the emergency. Diagnoses were classified as "other" when the data collected by the corpsman was contradictory or illogical either because of patient or corpsman error.

The computer made a diagnosis on 29 of the 32 cases. On the remaining 3 cases, the corpsmen failed to collect the information required by the computer for a diagnosis. The computer-generated diagnosis was exact or logically consistent with the dentist's diagnosis on 24 cases (83%). On the remaining 5 cases, 2 were non-matches (7%), and 3 were classified as other (10%). The corpsman recorded a diagnosis on 32 cases. The corpsman's diagnosis unaided by a computer was exact or logically consistent with the dentist's diagnosis on 22 cases (69%). Ten of the corpsmen's diagnoses were non-matches (31%). None was classified as other.

Corpsmen's Evaluation of the Questionnaire and Program

At the completion of the study, each corpsman completed a form evaluating the dental questionnaires and diagnostic program. The corpsmen read statements regarding the computer-assisted dental system and rated their agreement with the statement on a six point scale. The items addressed clarity of questions, familiarity with dental terminology, perceived usefulness of the system, and trust in diagnostic and treatment suggestions. A tally of the corpsmen's ratings for each item is given in Table 3. The corpsmen also identified problems they encountered and suggestions for improving the diagnostic system. The corpsmen's comments are in italics in Appendix A.

Table 3. The number of corpsmen (n=5) who marked each rating on items evaluating the dental questionnaires, branch points and the computer-assisted dental program. The bold-faced letter code preceding each item identifies whether the item addressed clarity of questions (C); familiarity with dental terms/procedures (F); perceived usefulness of the system (PU); or trust in diagnostic and treatment recommendations (T).

		Strongly Agree 1	2	3	4	5	Strongly Disagree 6
Dental Questionnaires							
(C)	Questions clearly worded	1	2	-	-	2	-
(C)	Questions in logical order	2	2	1	-	-	-
(F)	Familiar with terms in questionnaires	1	4	-	-	-	-
(PU)	Questionnaires useful for evaluating dental pain	2	-	1	1	1	-
(F)	More training required to perform procedures required by questionnaires	1	1	3	1	2	-
(PU)	Hard to select the most appropriate questionnaire	1	-	1	-	2	1
(PU)	Questionnaires are superfluous	2	2	-	1	-	-
Branch Points							
(C)	Branch points clearly worded	1	1	-	1	2	-
(C)	Branch directions easy to follow	3	1	1	-	-	-
(PU)	Eliminate branch points	-	1	-	-	3	1
Computer-assisted Dental Program							
(PU/T)	Use program for routine evaluations*	1[a]	1[b]	1[c]	1[d]	-	1[e]
(PU/T)	Use program only for emergencies*	1[d]	-	2[b,c]	1[a]	1[e]	-
(F)	HM are sufficiently trained to use program	1	2	-	-	1	1
(F)	Unfamiliar with terms used by program	-	1	1	1	2	-
(PU/T)	Tx recommendations not suitable at sea	-	-	2	1	1	1
(PU)	Classification of diagnoses into possible and probable helpful	2	2	1	-	-	-
(T)	I trust the program's diagnoses	-	2	1	1	1	-
(T)	CO/XO would trust the program's diagnoses	1	1	2	-	1	-
(PU/T)	I would consider tx recommendations in managing dental patients at sea	3	2	-	-	-	-
(F)	Program provides adequate definitions	2	-	-	2	1	-
(PU)	Program is a good supplement to dental textbooks**	2	-	1	-	-	-
(PU)	At sea, dental text should be in computer not book format	2	-	-	2	-	1

*The responses made by each corpsmen are identified by the letters a-e. Correct interpretation requires knowledge of the individual's combined ratings for these two questions.

**Two ratings were missing for this item.

Clarity of Questions

Four items concerned the clarity of questions or branch points used by the dental questionnaires and diagnostic program. These items are marked as "C" (clarity) on the form included in Appendix A.

Generally, the corpsmen felt that the directions given in the branch points were clearly worded and easy to follow. While the corpsmen felt that the questions used to collect information from the patient followed a logical order, some of the corpsmen felt that they could be more clearly worded.

Familiarity with Terms and Procedures

Five items addressed the corpsmen's familiarity with the terminology and the examination procedures required by the dental system. These items are marked as "F" (Familiarity) on the form (Appendix A).

The corpsmen rated themselves as familiar with the terminology used by the program. In their comments, they noted that the training of the independent duty technician is sufficient to perform the examinations procedures required by the program. Some of the corpsmen felt that the definition of terms or dental conditions provided by the program was inadequate and could be improved by more detail.

Perceived Usefulness Of System

Eleven items addressed the perceived usefulness of the dental questionnaires and the diagnostic system to the management of patients who present at sea with dental problems. These items are marked as "PU" (perceived usefulness) on the form (Appendix A).

These items showed that the corpsmen found the questionnaire superfluous and would prefer to enter patient information directly into the computer. In addition, some of the corpsmen had difficulty deciding which questionnaire to use to conduct the interview. Rather than answering all the items on the questionnaire, the corpsmen preferred to follow the directions in the branch points and answer only the items required by the computer for a diagnosis.

Items which addressed the perceived usefulness of the diagnostic/treatment program showed that all but one corpsman would use the system for the diagnosis and management of serious dental emergencies and that some of these corpsmen would also use the system in their routine evaluation of patients at sea with dental pain. One corpsman did not find the system useful. He felt that the books available to the corpsmen aboard a submarine provide sufficient information. All of the corpsmen would consider the treatment recommendations made by the program in their management of patients. While the corpsmen generally felt that the program provided a good supplement to the textbooks available aboard the submarine, opinion varied greatly on whether or not to have all dental text in computer rather than book format.

Trust in Diagnostic and Treatment Recommendations

Six items addressed the corpsmen's trust in the diagnostic and/or treatment recommendations made by the system for the management of dental patients. These items are marked "T" (Trust) on the form (Appendix A).

The corpsmen's trust in the dental diagnostic system was variable. None of the corpsmen either strongly trusted or distrusted the diagnoses made by the system; they were more on the neutral side in their evaluation. It is interesting that all but one corpsman felt that the Commanding and Executive Officers of the submarine would trust the diagnoses made by the program. It is also interesting that while the corpsmen were not certain of their trust in the system, all would take into consideration the treatment recommendations made by it.

Discussion

The computer generated a diagnosis which was exact or logically consistent with the diagnosis made by the dentist 83% of the time. The findings reported here are in agreement with previous studies reporting a diagnostic accuracy of 88% for 80 real patients and 78% for 79 simulated cases. While earlier studies used data collected by either Navy dental technicians or dentists, this is the first time that the accuracy of the dental program has been evaluated with data collected by Navy hospital corpsmen.

The primary purpose of this study was to learn of difficulties encountered by corpsmen in using the dental program and to obtain their suggestions for improving the system to best meet the needs of the independent duty technicians at sea. The corpsmen had difficulty both in selecting and using the dental questionnaires to guide their interview. Except for tooth specific problems, the corpsmen's selection of a dental questionnaire rarely corresponded to the dental category selected by the dentist. In addition, the corpsmen made errors in following the directions given by the branch points. In a few cases, these errors resulted in the collection of insufficient information for the computer to reach a diagnosis. In their subjective ratings of the system, the corpsmen did not like using the dental questionnaires and preferred to enter information directly into the computer program. Direct entry avoids the problem of collecting unnecessary or insufficient information as the program guides the user from question to question.

Whether the corpsman records symptom findings on a questionnaire or enters information directly into the program, he must first classify the patient's dental problem into one of ten categories. Accurate diagnosis by the program is dependent on user classification of the patient into the appropriate dental category. In this study, the corpsmen usually classified the patient's presenting dental problem as one related to a specific tooth. The dentist and corpsmen failed to agree on their classification of the dental problem for one-third of the dental patients. The corpsmen would clearly benefit from additional assistance in the classification of the presenting dental problem. For example, the program could be modified to use data (e.g. location, duration and type of pain) collected in an initial evaluation of the patient to classify the patient into the most appropriate category.

Despite their difficulties, the corpsmen liked the program. Most of them would use the dental program in the diagnosis and management of serious dental emergencies, but not always in their evaluation of routine dental problems. The corpsmen felt that when they were confident of their own diagnosis and treatment plan, use of the program would be a waste of time. When they were less sure, they would welcome the assistance. While the corpsmen did not always trust the diagnoses made by the program, they would always take into consideration the treatment recommendations made by the dental program. The corpsmen valued the dental diagnostic system as a "second opinion". One corpsman felt that the program kept him thinking "in the right direction". Another corpsman thought the system might give the Commanding and Executive Officers more confidence in the corpsman's management of the case. The corpsmen found the treatment and management recommendations provided by the program especially helpful.

The corpsmen were asked to consider the disadvantages of the program. One concern was that a corpsman who is unsure of his own skill may rely too heavily on the program, rather than using it as a diagnostic aid. Two of the corpsmen felt that the evaluation of most dental pain does not require the assistance of a computer diagnostic program. They questioned whether the need justified the expense of the system.

The corpsmen suggested ways to improve the program. The current version of the dental program does not allow the user to return to previous pages, either to review or to make changes in data entry. Instead, the user must return to an earlier menu and begin data entry for that patient from the start. The corpsmen suggested that the user be allowed to proceed to and from successive pages, providing more flexibity in data entry. Symptom information is collected about the patient by responding to a set of questions. The corpsmen found the wording of some of the questions unclear and suggested rewriting them. Definitions of terms, procedures, and dental conditions can be accessed by the user from within the computer program. The corpsmen found the definitions inadequate and suggested that they be written in greater detail. These suggestions are included in projected enhancements of this program for future release from this laboratory.

Summary

Navy hospital corpsmen conducted interviews of 32 patients with acute dental pain. Symptom findings were entered into a computer-assisted program for the diagnosis and management of dental conditions. The computer generated a diagnosis which was exact or logically consistent with the diagnosis made by the dentist 83% of the time.

While only five corpsmen participated in this study, it is our belief that the views of these corpsmen are representative of Navy hospital corspmen as a group. The corpsmen found the computer-assisted dental program valuable to the diagnosis and management of patients with dental pain. They would use the program in their management of dental emergencies which occur at sea and found the treatment recommendations especially helpful. In future revisions, the corpsmen requested more flexibility in data entry, questions that were more clearly worded, and greater detail to definitions of terms, procedures and dental conditions.

REFERENCES

1. Ralls SA, Southard TE, Cohen ME: A system for computer-assisted dental emergency diagnosis. Military Medicine, 151:639-642, 1986.

2. Ralls SA, Cohen ME, Southard TE: Computer-assisted dental diagnosis. Dental Clinics of North America, 30:695-712, 1986.

3. Fisherkeller KD, Beaudry R: Accuracy of a computer-assisted program for "classic" presentations of dental pain. Naval Submarine Medical Research Laboratory Report No. 1136, 1989.

APPENDIX A

The following form was used to evaluate the dental questionnaire and diagnostic program. The items addressed clarity of questions, familiarity with dental terminology, perceived usefulness of system, and trust in diagnostic and treatment suggestions. Next to each item is a letter code identifying the type of item. They are C: Clarity of Questions; PU: Perceived Usefulness of System; F: Familiarity with Terms and Procedures; and T: Trust in Diagnostic and Treatment Recommendations. The letter codes did not appear on the form completed by the corpsmen. The corpsmen's comments and suggestions in Sections II and IV are in italics.

SECTION I

The following questions relate to the dental questionnaires. We are interested in evaluating the usefulness of this form for conducting an interview of patients with dental pain. Your responses will be help to create a form that can be used by Independent Duty Corpsmen at sea in their management of dental injuries. Please answer each item by circling the number which best corresponds to your response.

Example:

I like my car.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

Since I drive a beaten up old car and I don't like old cars, I circle the number 6 indicating that I strongly disagree with the statement "I like my car".

C: 1. Questions were clearly worded.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

C: 2. Questions followed a logical order.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

F: 3. Corpsmen are familiar with most of the terminology used in the dental questionnaires.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

PU: 4. The dental questionnaires would be useful to corpsmen at sea in evaluating patients with dental pain.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

F: 5. Corpsmen need supplementary training to perform examination procedures required by the dental questionnaires.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

PU: 6. It was difficult to decide which of the ten questionnaires to use in interviewing the dental patient.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

PU: 7. Dental questionnaires are superfluous. I would prefer to enter data directly into the computer based dental program.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

In the dental questionnaires, branch points were printed in bold face and direct the user to subsequent questions based on response(s) to previous questions. While most branch points are straight forward because the branch is based on a response to a single question, some are more complicated. Branch points allow the user to skip some of the questions. An example of a branch point is: "ON QUESTION 3, IF "NO"(2), THEN GO TO QUESTION 5". The following set of questions concern branch points.

C: 1. Branch points were clearly worded.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

C: 2. The directions given by the branch points were easy to follow.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

PU: 3. It would be better to eliminate branch points, although it would mean answering all items on the questionnaire.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

SECTION II

We want to hear your opinion of the dental questionnaires. Your comments and suggestions will be used to improve the dental questionnaires.

1. What problems do you foresee in administering the dental questionnaires. Please, be specific.

   Eliminate soft tissue section, because the corpsman can not make a determination of the diagnosis as would a doctor or dentist.

   I had no problems. Questionnaires are an unnecessary step when the computer asks the same questions.

   Following the directions in the branch points was annoying. It is better to go straight through the program.

   The questionnaires would be superfluous if the computer is available. Once I became more experienced with the branch points, I found the questionnaire easier to use.

2. Do you have any suggestions to improve the dental questionnaires? Be specific.

   Make some of the questions more specific.

   Get rid of the questionnaires and work directly with the computer.

3. Other comments.

   The training given independent duty technicians covers dental examination procedures.

   Independent duty technicians are trained in the procedures required by the dental program.

SECTION III

The following questions concern the computer based diagnostic program for dental injuries. We are interested in hearing your feelings regarding the usefulness of this diagnostic program to Navy Hospital Corpsmen. Your responses will help us to create a program that can be used by Independent Duty Corpsmen at sea in their management of dental emergencies. Please answer each item by circling the number which best corresponds to your response.

PU/T: 1. I would use this program in my routine evaluation of patients at sea with dental problems.*

1 2 3 4 5 6
Strongly Agree Strongly Disagree

PU/T: 2. I would use this program only for the diagnosis and managment of serious dental emergencies.*

1 2 3 4 5 6
Strongly Agree Strongly Disagree

F: 3. Navy Corpsman are trained in the examination procedures required by the diagnostic program.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

F: 4. I was unfamiliar with much of the terminology used by the diagnostic program.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

PU/T: 5. Treatment recommendations suggest I do things that I can not do at sea.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

PU: 6. I found the classification of diagnoses into probable and possible helpful.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

*The responses made by each corspman are identified by the letters a-e. Correct interpretation requires knowledge of the individual's combined ratings for these two questions.

T: 7. I trust the diagnoses made by this program.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

T: 8. I think my CO/XO would trust the diagnoses made by this program.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

PU/T: 9. I would take into consideration treatment recommendations made by the program in my management of patients at sea.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

F: 10. The program provides adequate definition of terminology.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

PU: 11. This program provides a good supplement to the dental textbooks kept aboard submarines for the management of dental injuries at sea.*

1 2 3 4 5 6
Strongly Agree Strongly Disagree

* Two ratings were missing.

PU: 12. Aboard submarines, I would rather have all dental text in computer rather than book format.

1 2 3 4 5 6
Strongly Agree Strongly Disagree

SECTION IV

We want to hear your comments and suggestions regarding the computer based dental diagnostic program. Your feedback will help us to create a program that will meet the needs of the corpsman.

1. Did you encounter any problems in using this program? Please, be specific.

   No

   No

   A couple of questions requested more than one piece of information and could not be answered with a "Yes" or "No" response.

   I could not back up to previous pages.

2. Do you have any suggestions to improve the computer based dental diagnostic program? Be specific.

   Eliminate soft tissue section.

   Leave soft tissue section out.

   Give more detail to definitions of terms and diseases.

   More definitions.

3. What do you consider the advantages of this program?

   You have a second opinion at your fingertips.

   The program keeps me flowing in the right direction en route to a correct diagnosis.

   I liked the treatment and managment recommendations.

   I found no real advantage. If the patient has pain, then give pain medication. If the patient has an infection, then give antibiotics. The corpsman's textbooks shows how to treat any dental problem.

   Excellent back up system. The system would give the Commanding and Executive Officers more confidence in the diagnosis.

4. What do you consider the disadvantages of this program?

The corpsman will rely on the program to the extent he is unable to make his own diagnosis.

Most dental emergencies are easily seen and do not require computer assistance.

I don't think it justifies the expense. All of my patient's could be diagnosed after one glance in the mouth.

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S): NSMRL Report # 1141	5. MONITORING ORGANIZATION REPORT NUMBER(S): NA
6a. NAME OF PERFORMING ORGANIZATION: Naval Submarine Medical Research Laboratory; 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION: Naval Medical Research and Development Command
6c. ADDRESS (City, State, and ZIP Code): Naval Submarine Base New London Groton, CT 06349-5900	7b. ADDRESS (City, State, and ZIP Code): NMC NCR, Bethesda, MD 20814-5044
8a. NAME OF FUNDING/SPONSORING ORGANIZATION: Same as 7a; 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code): Same as 7b	10. SOURCE OF FUNDING NUMBERS: PROGRAM ELEMENT NO. 62233N; PROJECT NO. MM33C30; TASK NO. 002; WORK UNIT ACCESSION NO. 5044

11. TITLE (Include Security Classification) (U) Evaluation of a computer-assisted dental diagnostic system by Navy hospital corpsmen

12. PERSONAL AUTHOR(S): Karen Fisherkeller and Robert Beaudry, CAPT, DC, USN

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Interim	FROM _____ TO _____	1989 June 23	18

16. SUPPLEMENTARY NOTATION

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Computer-assisted; dental pain

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

A computer-assisted diagnostic and treatment program for dental pain was developed at the Naval Dental Research Institute, Great Lakes, IL, and later adapted to MS-DOS format and implemented on an IBM-PC/AT by the Naval Submarine Medical Research Laboratory (NSMRL), Groton, CT. The program is rule-based, designed for use with trauma and non-trauma related dental emergencies, and for the differential diagnosis of soft tissue lesions. The program is intended for use by independent duty corpsmen in their management of patients who present with dental pain at sea.

The computer-assisted dental program was tested in a large Navy dental clinic with data collected by a dental technician, and a diagnostic accuracy of 88% was reported for 80 real patients on a subset of dental conditions considered by the program. In a subsequent study, the program was successful 78% of the time in making a correct diagnosis for 69 simulated cases agreed on by a panel of dentists to be classic

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION: UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL: Susan D. Monty, Publications Office	22b. TELEPHONE (Include Area Code): (203) 449-3967; 22c. OFFICE SYMBOL: 421

DD Form 1473, JUN 86 *Previous editions are obsolete.* SECURITY CLASSIFICATION OF THIS PAGE

S/N 0102-LF-014-6603 UNCLASSIFIED

19. Cont'd.

representations of dental conditions. In addition, the program correctly distinguished between dental conditions requiring immediate evacuation and those which can be managed aboard the submarine by the corpsman.

Up to now, the dental diagnostic program has not been used by Navy hospital corpsmen. This paper reports on a study where Navy corpsmen used the dental program in their diagnosis of real patients with acute dental pain. The main objective of the study was to collect data on difficulties encountered by the corpsmen in using the system and to obtain the corpsmen's feedback regarding the usefulness of the system for managing patients with dental pain.

Navy hospital corpsmen conducted interviews of 32 patients with acute dental pain. Clinical findings were entered into the computer-assisted dental program. The computer generated a diagnosis which was exact or logically consistent with the diagnosis made by the dentist 83% of the time. The corpsmen found the computer assisted dental program valuable to the diagnosis and management of patients with dental pain. They would use the program in their management of dental emergencies which occur at sea and found the treatment recommendations especially helpful. In future revisions, the corpsmen requested more flexibility in data entry, questions that were more clearly worded, and greater detail to definitions of terms, procedures, and dental conditions.